Configurable and computable instructional model based on gamification elements: a case study on education in software engineering

Modelo instruccional configurable y computable basado en elementos de gamificación: un estudio de caso sobre la educación en ingeniería de software

http://dx.doi.org/10.18381/Ap.v12n2.1905

Raúl Antonio Aguilar Vera*
Erika Eunice Briceño Arceo**
Julio Cesar Díaz Mendoza***
Juan Pablo Ucán Pech****

Keywords
Gamification; education; engineering; software; instructional model

ABSTRACT

This article describes a configurable and computable instructional model based on gamification elements. The empirical evaluation of the model is also reported using the software engineering area as the scope of application; in the experimental study two treatments were compared: the traditional dynamics of using a paper document for the Performance Test, and the use of a Virtual Learning Environment configured based on in the model; the dependent variables considered were time and score. From the statistical analysis it was possible to conclude that the students did not present significant differences in the scores obtained in both treatments; however, the time turned out to be a variable with significant differences.

Palabras clave
Gamificación; educación; ingeniería; software; modelo instruccional

RESUMEN

En este artículo describimos un modelo instruccional configurable y computable basado en elementos de gamificación, así como su evaluación empírica; el área de ingeniería de software es el ámbito de aplicación. Comparamos dos tratamientos: la dinámica tradicional de utilizar un documento en papel para la prueba de desempeño y el uso de un entorno virtual de aprendizaje configurado con base en el modelo citado. Las variables dependientes consideradas fueron el tiempo y el puntaje. Del análisis estadístico, concluimos que los estudiantes no presentan diferencias significativas en los puntajes obtenidos en ambos tratamientos; sin embargo, el tiempo resultó ser una variable con diferencias importantes.

Received: October 3, 2019
Accepted: April 1, 2020
Online Published: September 29, 2020

* PhD on Software Engineering by the Polytechnic University of Madrid. Professor at the Autonomous University of Yucatan, Mexico. ORCID: https://orcid.org/0000-0002-1711-7016
** Master on Computacional Sciences by the Autonomous University of Yucatan. Collaborator of the Faculty of Software Engineering for Education. ORCID: https://orcid.org/0000-0001-5074-5463
*** Master on Information Technology by the Inter-American University for Development. Professor at the Autonomous University of Yucatan, Mexico. ORCID: https://orcid.org/0000-0002-3005-3432
**** PhD on Computer Systems by the Universidad del Sur. Professor at the Autonomous University of Yucatan, Mexico. ORCID: https://orcid.org/0000-0002-1013-6396

INTRODUCTION

Learners' lack of commitment and motivation in the educational area to actively partake in the learning process has been one of the most recurring issues, and one of the strategies more frequently used is the incorporation of games as an instructional dynamic. It is clear that games improve the active commitment of learners to make decisions; furthermore, seeing participants in the game dynamic makes it evident that an emotional participation may result in an intrinsically stimulating factor for the activity performed by the individual, regardless of the environment.

Over the last two decades a variation of this instructional dynamic has emerged dubbed as gamification, which is described as the use of metaphors, elements and ideas of the game within a different context to arouse motivation and commitment and to have an influence on the behavior of the user (Marczewski, 2013).

Our purpose is that of describing a research project which results in a proposal of a configurable instructional model – by the teacher, as a function of the interaction required by the learner – and computable – to be used in scenarios with mixed or virtual educational modes – based on gamification elements. This model has been employed by way of exploration by authors in the field of education in software engineering, who obtained positive results in their first empirical assessment.

GAMIFICATION AS A STRATEGY IN EDUCATION

The basic idea of gamification is to take advantage of the motivational power of games for purposes other than the entertainment feature of a game *per se*. This idea originates in the marketing area, which extended to different contexts connected with businesses (Werbach & Hunder, 2012). "Gamification is defined as the use of game design elements in contexts that are not games." (Deterding *et al.*, 2011, p 10).

Motivation refers to energy, direction and persistence in every aspect of activation and aim. This topic has been researched for decades now in the field of psychology because it is at the center of the biological, cognitive and social regulation regarding an individual's performance. For this reason, it is valuable for people who work as managers, instructors, religious leaders, trainers, providers of health services, and parents, who involve mobilization for someone else's performance (Ryan & Deci, 2000). When people are motivated, they tend to be more consistent and, at the same time, they pay more attention to new events and to unexpected possibilities; at times, they need more time to make decisions, to gather and process information, as well as to appreciate well done and integrated products, which may lead to deeper learning.

Over the past years, gamification has aroused a growing interest among scholars and professionals in different areas of the community (e.g., medicine, businesses, military, education, among others) and with different purposes (Johnson *et al.,* 2016; Hamari, Koivisto & Sarsa, 2014); in the specific case of higher education, it was used to raise motivation among learners and, therefore, generate better conditions to foster learning (Lozada & Betancur, 2016; Prieto, 2020).

Kaap, Blair and Mesch (2104) have established a classification consisting of two structural and content gamification strategy types. It is important to consider that these schemes are mutually exclusionary, and the combination thereof may even give rise to environments of greater motivation for learning.

Structural gamification is the application of game elements to encourage learners through the content without making alterations or changes in the learner. By means of this strategy, content does not look like a game; however, the structure is the same. In this case, the main focus is to motivate learners into reviewing the content and to involve them in the learning process by means of rewards. The most common elements in this gamification include points, badges, achievements and levels; leaderboards and follow-up methods for the learning progress are usually included, as well as a social component, where the learners may share their achievements with other learners and be proud of what they have attained. Although it is likely to add different elements of history (such as characters), the content will not change to become a game.

On the other hand, gamification of content consists of applying game elements, in addition to thinking on the game, to alter content and to make the strategy look like a game; e.g. to incorporate elements of history to a course of commitments or to begin a course with a challenge instead of a list of objectives; both are content gamification strategies. Adding these elements together makes the content look more like a game, but it will not become a game, it simply provides the context or the activities used in games and incorporated them to the content that is taught.

Werbach and Hunter (2012) propose a gamification element organization scheme in three different levels (see figure 1). The dynamics are at the top level, which determine learners' behavior and that are related to our learners' motivation. The mechanics are at the middle level, which represent the basic process which drives the action and generates participation of the player. The components are on the last level, which represent specific forms that may take the mechanics or dynamics or, in other words, resources available, as well as tools we may use to design an activity based on gamification.

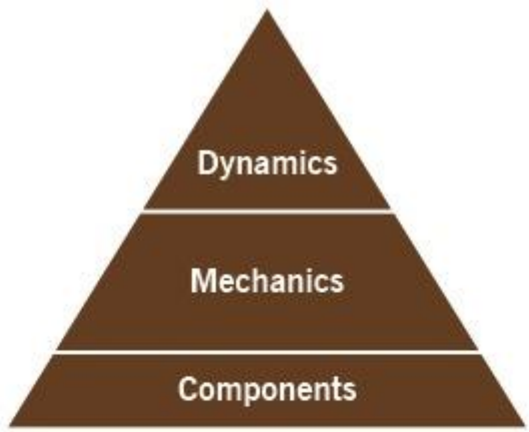


Figure 1. Pyramid of gamification elements.
Source: Werbach & Hunter (2012).

In spite of the existing theoretical framework, most of primary studies available are focused on *ad hoc* experience and not in formal design processes (Mora *et al.,* 2017); conversely, most of these empirical studies do not include proper assessment (Diecheva *et al.,* 2015). It is important to make emphasis in the fact that the findings mentioned above furthered, to a large extent, the development of a proposal presented herein.

METHODOLOGY

This work is the result of a research and development study (Gall, Borg & Gall, 2003), whose tasks, as part of the project, were as follows:

- Systematic literature review. The purpose of this task was to identify, evaluate and interpret all the research available – primary studies – aimed to answer a set of specific research questions about education in software engineering. We used gamification as a pedagogic strategy to motivate learners (Briceño *et al.,* 2019).

- Designing an instructional proposal. The purpose of the second task was to design an instructional model which could be configurable – regarding interaction dynamics – and computable – to be employed in the mixed mode – based on previously identified gamification elements, which could be used to create learning scenarios.
- Developing technology. The purpose of this task was to apply a disciplined, systematic and quantifiable approach for the development of software; i.e., to use the software engineering process in order to develop a prototype that is to be used in the managing system of learning environments.
- Designing learning scenarios. Based on the selected proficiency learning –topics of software engineering– we designed learning scenarios to explore the feasibility of educational interventions based on gamification principles aimed to strengthen the learning process of learners.
- Empirical assessment. This task was focused on planning and executing a series of pilot tests with learners, whose intention was to evaluate the proposal and to gather feedback by actual users and to contrast several alternatives. This was developed in the context of a software engineering course of studies.
- Introspection and assessment. Based on obtained empirical assessment reports, we analyzed the results and made a reflection on lessons learnt from applying the instructional model.

INSTRUCTIONAL MODEL

Based on a review made on the state of the art on gamification (Llorens Largo *et al.*, 2016) and on the findings from the systematic review of literature of the first stage of our research (Briceño *et al.*, 2019), we designed a proposal for an instructional model based on gamification elements to further learning in a specific knowledge area, in software engineering.

The proposal makes use of four gamification elements supporting the model: complexity level, accrual of points, obtaining badges and feedback.

- For implementation purposes of the first element, complexity level, the proposal uses the first four levels of Bloom's taxonomy as reference: knowledge, comprehension, application and analysis.
- The dynamics regarding accrual of points is the assignment of specific points for completed challenges, which are accrued during the whole process.
- As a third element, the model incorporates the assignment of badges as recognition for the performance of the instructional

process, in cases where the learner may earn them in the first scheme.
- Finally, the feedback element reinforces or promotes (as the case may be) learning not yet assumed or reached in a partial manner.

Furthermore, the model incorporates two other elements: the progress bar and the leaderboard. The former shall specify a learner's advance and the latter shall show accrued points of all the participants in the environment.

In order to organize the model, we have developed three constructs based upon which it is possible to configure learning environments, as agreed by the instructor: challenge, block and scheme.

- Challenge: this is implemented by means of a structured answer quiz on a specific complexity level, which incorporates a limited number of possible answers, the achievement of which will facilitate the accrual of points by the learner.
- Block: this is made by a set of *n* challenges; it must be mentioned that, within a block, challenges are at the same complexity level.
- Scheme: this is made by a set of blocks with a progressive complexity level, as well as by differentiated interaction dynamics (individual, peer-competitive, and peer-collaborative).

The top configuration of the instructional model proposed herein is comprised of up to three different schemes which implement the three interaction dynamics considered for the virtual learning environment (VLE).

Scheme 1 (see figure 2) uses an individual type of interaction and can be formed by two or four blocks, each with a different complexity level, in accordance to Bloom's taxonomy: in block 1, the learner faces challenges in the knowledge level; block 2 has challenges with the comprehension level; block 3, challenges at the application level; and block 4 includes challenges at the analysis level. The model proposes that in scheme 1, the number of challenges comprising each block be different and in decreasing numbers; thus, block 1 would be formed by *m* challenges; 2, by *n* challenges; 3, by *o* challenges and 4, by *p* challenges, where $m>n>o>p$. Each challenge shall be designed with four answer options and shall have a specific score assigned.

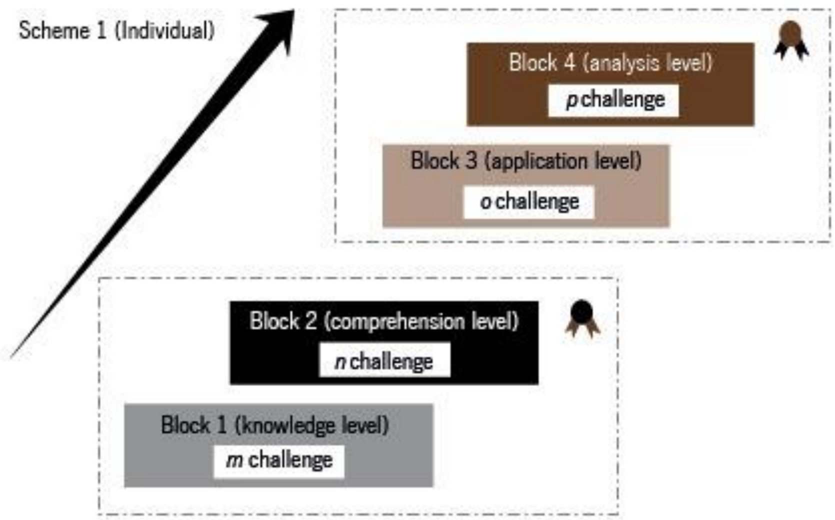


Figure 2. Representation of scheme 1 (individual).

Regarding works dynamics, the learner shall have two attempts to give a correct answer to each challenge: should he provide a correct answer in the first attempt, he shall have the total of points assigned; in the event he makes a mistake, he shall have a second attempt to answer the three remaining answer choices, if the answer is correct, he shall have accrued 50% of the points assigned to the challenge, even if he gives a wrong answer, he may obtain feedback regarding the ongoing challenge. This feedback-related dynamic may be offered with a maximum of two scenarios within the scheme.

In the event a learner needs feedback for the third time, he shall have an invitation to study the relevant topic. The model considers that a learner shall have lost accrued points thus far in this scheme and shall start from the beginning. In this first scheme it is provided that two possible badges are assigned, the blue one may be earned by a learner when he provides a correct answer in the first attempt to the challenges in blocks 1 and 2; the red badge may be earned when the learner completes the challenges of blocks 3 and 4 in the first attempt.

In accordance with the proposed instructional model, scheme 2 implements the peer-competitive interaction type and is made by two blocks, with challenges at the knowledge and understanding levels, respectively (see figure 3). Just as in scheme 1, the number of challenges for each block is different and in decreasing numbers.

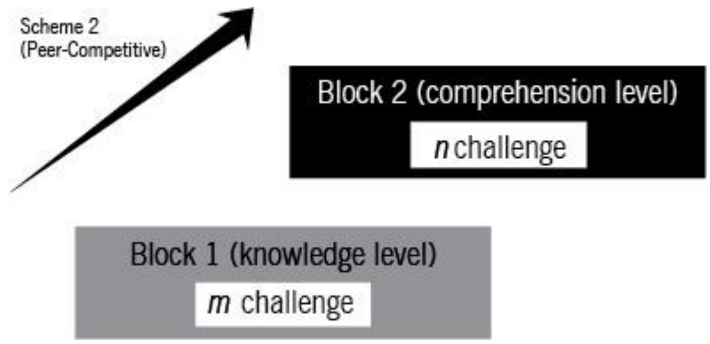


Figure 3. Representation of scheme 2 (peer-competitive).

Based on the proposed interaction dynamic for scheme 2, a learner competes with another peer to earn a turn; once this has been assigned, he may answer the challenge; if the answer is correct, he shall earn the points for this challenge, however, if a wrong answer is provided, the virtual environment shall assign the turn to the second learner, who may choose among the three remaining answer choices and, if he provides a correct answer, he shall have earned the points assigned to the challenge. It should be noted that if none of the learners overcomes the challenge, the dynamic of scheme 2 allows that the blue badge be changed for a second attempt to answer the challenge and choose between the two remaining answers. If both learners earn said badge, they shall compete for the turn and for exchanging it.

Finally, in accordance with the proposed instructional model, the third scheme shall make some kind of a peer-collaborative interaction and shall also be formed by two blocks with challenges at the application and analysis levels (see figure 4). Just as in scheme 2, the number of challenges contained in each block is different and in decreasing numbers. Based on the dynamic of this scheme, two learners shall work together to solve the challenges in the relevant blocks. The learners may communicate with each other by means of a tool (for example, chat) to discuss ideas and reach an agreement, with the purpose of providing a correct answer to the questions. The intention here is that a collaboration level be achieved at any time during the performance of the VLE.

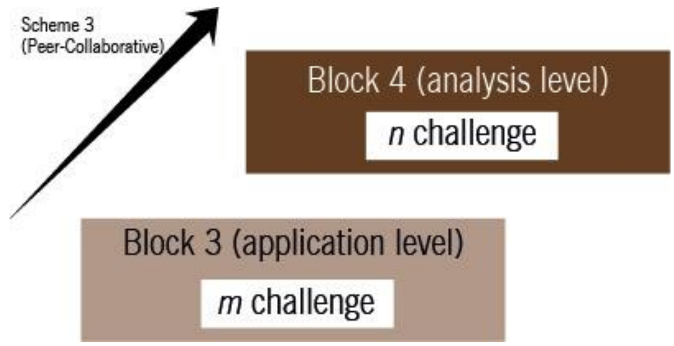


Figure 4. Representation of scheme 3 (peer-collaborative).

The challenges in both levels is always in even numbers, because the learners shall have the roles as –interchangeably– representative and assistance as they move forward in the scheme; the representative interacts with the challenges and the assistant analyzes, together with his peer, the correct answer. In this third scheme, when a learner gives a wrong answer, this allows that the badge be exchanged for a second attempt to answer the challenge, regardless of whose turn it is.

EDUCATION IN SOFTWARE ENGINEERING

Software engineering is a discipline arising in the second half of the twentieth century, and in Mexico, it is considered as a profession as of the beginning of the current century (Aguilar & Diaz, 2015); the foregoing notwithstanding, in spite of having a body of knowledge accepted by scholars and practitioners (Bourque & Fairley, 2014), there still are problems regarding what the best practices are for their development and managing processes, as well as for processes linked to their education, i.e., teaching and learning.

Using gamification as an instructional dynamic has been considered more and more as a feasible strategy in software engineering education (Schefer-Wenzl & Miladinovic, 2018). This dynamic increased the commitment and motivation of learners as it allows an independent learning with a flexible speed and selection on emphasis (Berkling & Thomas, 2013).

In the case of group dynamics, gamification may encourage the member of a group to meet their job objectives and, even group cohesion level may be improved in collaboration dynamics (Hernandez, *et al*., 2017); therefore, the relevant use of gamification elements to promote improvement both of education processes and processes related with the development of software is a unique point of interest for the proposal (Briceño *et al.*, 2019).

EMPIRICAL ASSESSMENT

Aimed to assess the proposed instructional model, we have devised a first empirical study, we generated and configured a virtual environment based on an *ex profeso* learning scenario on a software engineering topic. It should be noted that several restrictions were foreseen in the assessment linked to the course dynamic where it was to be conducted.

Restrictions

We have agreed to design learning scenarios on topics related with software engineering education; specifically, that they be included in the syllabi of the Bachelor's Degree in Software Engineering (curricular syllabus offered by the Autonomous University of Yucatan) (Aguilar & Diaz, 2015), and specifically, in courses where the members of a research group would have an active participation. Conversely, aimed to having the course dynamics least affected where empirical validation sessions would be provided, we have devised scenarios that would be taken by learners in single learning sessions, therefore, we have configured learning spaces that would be implemented in independent schemes of the model.

Learning Scenario

The first scenario is limited to the subject of Database Design, taught on the fifth semester degree in Engineering and where the didactic planning is established as learning competence: "[The learner will] design a database logical structure for the solution of a real world problem by using appropriate models and techniques". In order to attain this competence, the content is organized in five units: Database foundations, The entity-relation model, The relational model, Standardization and Structured Query Language.

The learning scenario used as reference the first scheme of the model, i.e., it was conceived to assess knowledge individually (interaction type) on topics of the subject, specifically, aspects of the first four units. It is worth clarifying that the contents of unit five were not included in the study because the classroom session where the assessment was to be performed was interspersed with the sessions of the last weeks of the course analyzing the topics of this unit. For this learning scenario, we designed a set of challenges in accordance with the topics of the first four units and with the levels of knowledge of the four blocks comprising scheme 1. Table 1 shows the number of challenges designed for the first scenario.

Table 1. Number of challenges devised for scenario 1.

Block	# Challenges designed
I	40
II	14
III	15
IV	2

Experimental study design

We used the scenario described in the previous section as reference aimed to configure an *ad hoc* VLE (see table 2) and registered the learners of the experimental group, who enrolled in the 2019 August-December term, in one of the groups of the Database Design subject. It should be mentioned that the participation of learners was not compulsory. The dynamic was designed as an additional learning activity to the course and its score –added to that of the course– would be as a function of the results obtained. Table 2 shows the score configuration for VLE.

Table 2. Configuration of the virtual learning environment

Block	# Challenges	Points per challenge	Total per block
I	10	2	20
II	6	4	24
III	4	6	24
IV	2	16	32
Total score of the VLE			100

The 21 learners who voluntarily participated in the experimental study were assigned at random to one of the two groups: Group A (the control group with seven learners) was assessed by means of a paper-based instrument with challenges randomly selected from among the challenges designed for the study, and group B (the experimental group with fourteen learners) was assessed by means of VLE. The paper-based instrument used the same configuration as that of VLE.

With the purpose of exploring the goodness of the proposed instructional model as compared to traditional methods, we took depending variables into consideration whose operational definitions are described below:

- Time: this refers to the minutes used by a learner to complete the task.
- Score: the number of points earned by a learner in a session.

Table 3 represents the metrics for the two variables of each of the 21 experimental subjects divided in the groups: control (group A) and experimental (group B).

Table 3. Metrics of time and scores earned by participants allocated to the groups.

Subject	Group A	Group B	Time	Score
1	×		30	64
2	×		28	66
3		×	22	53
4		×	35	66
5	×		29	70
6		×	14	73
7		×	14	68
8		×	19	93
9	×		28	90
10	×		28	66
11		×	19	70
12	×		44	48

13		×	21	79
14		×	19	78
15		×	26	75
16		×	23	53
17		×	22	60
18	×		25	32
19		×	33	68
20		×	27	0
21		×	14	79

In our study, the controlling factor was the type of scenario used for the activity, and factor alternatives were paper-based performance test (PD) and VLE (software). The experimental session was planned in four stages:

- Description of the session dynamics.
- Description of VLE targeted to learners of group B.
- Development of the learning activity.
- Administering an instrument to gather the opinions of learners of group B.

Descriptive Analysis

Based on the metrics obtained for the points variable, we prepared a statistical summary which may be analyzed in table 4. We can see that the learners under a traditional scheme for the learning activity

(PD) managed to earn an average score of eight points less than those who used the VLE; likewise, this group reported a much greater variability –about seven units– of points. The score range obtained by means of the performance test alternative was broader by 18 units in respect to the VLE alternative and included lower values. It should be noted that in the case of learners of the B group, we made the decision of discarding the metrics of learner number 20, because this did not represent the correct evaluation (it was not recorded by VLE).

Table 4. Statistical summary for the points variable

Factor	Count	Average	Standard deviation	Minimum	Maximum	Range
PP	7	62.2857	18.1633	32.0	90.0	58.0
EVA	13*	70.3846	11.1396	53.0	93.0	40.0
Total	20	67.55	14.0805	32.0	93.0	61.0

*A student was discarded who asked to begin again due to having required feedback three times

Regarding the time variable, it may be seen in the statistical summary (see table 5) that the learners who were assessed by using the traditional scheme (PD) used, in average, about eight more minutes to complete their session, as compared to those who used VLE; the foregoing notwithstanding, the standard deviation was slightly lower. Conversely, although the range obtained by using the first alternative is lower by two units of time, the values are higher.

Table 5. Statistical summary for the time variable

Factor	Count	Average	Standard deviation	Minimum	Maximum	Range

PP	7	30.2857	6.23737	25.0	44.0	19.0
LVE	14	22.0	6.51625	14.0	35.0	21.0
Total	21	24.7619	7.43576	14.0	44.0	30.0

Inferential analysis

With the purpose of making a statistical analysis that would evidence likely differences between the two alternatives of our controlled factor, for the points variable, we proposed a couple of statistical hypotheses.

H1o: μPD = μEVA; *H1a*: μPD <> μEVA

For the inferential analysis, we used the variance analysis (ANOVA), which has helped us to make a statistical evaluation of the significance of the difference between the two groups. This analysis breaks down the variance of the points variable into two components (see table 6), one between-groups and one within-groups (Gutierrez & De la Vara, 2012). The F-ratio, which in this case is 1.55, is the quotient between the estimate between-groups and the estimate within-groups. Considering that the P value of the F ratio is greater than or equal to 0.05, we would be in the condition of sustaining that there is no significant statistical difference between the PD alternative and VLE for the points variable.

Table 6. Results of ANOVA for the points variable

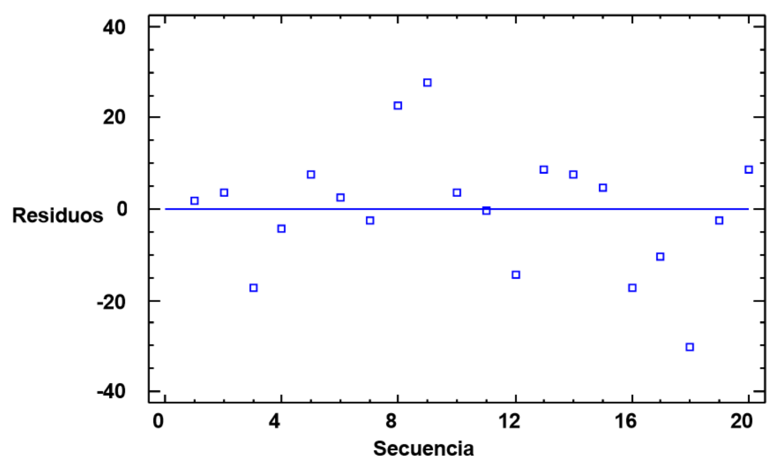
Source	Sum of squares	Df	Mean square	F-Ratio	P-Value
Intergroup	298.445	1	298.445	1.55	0.2293
Intragroup	3468.51	18	192.695	-	-

Total	3766.95	19	-	-	-

In order to consider that this is a valid result, it is necessary to evaluate the three assumptions of the ANOVA model: normality, homoscedasticity and independence of data. Under the normality assumption, we have applied the Shapiro-Wilkis test to residuals and obtained a *p*-value greater than 0.05 (0.5606), which is an indication that data behave in accordance with the normal distribution. In order to validate homoscedasticity, we performed the Levene test, with the result of a *p*-value of 0.3120; based on this, we can sustain that there is no significant statistical difference between the standard deviation, with a confidence level of 95.0%. Finally, in order to validate data independence, we decided on a graphic analysis, so we used the residual graph per sequence (see the graph). In this graph it can be seen that there is no specific behavior of data, rather, the values are dispersed, and we can conclude that the third assumption has been complied with.

With already validated assumptions of the model, it is likely to affirm that there is no statistical significant difference for the median of the points variable between both alternatives, with a level of significance of 5%; that is, statistically, it is not possible to reject the hypothesis of nullity and it turns out that the valid hypothesis is:

$$\mu PD = \mu EVA$$



Graph. Graph of residuals per sequence for the points variable

In the same manner from the previous analysis, we went on to make a statistical analysis of the likely differences between the two alternatives, we considered the time variable, and we proposed the following statistical hypothesis:

H2o: μPD = μEVA; *H2a*: μPD < > μEVA

By applying ANOVA, we obtained a *p* value lower than 0.05 (0.0118), which is an indication that there is a significant statistical difference in the media of the time variable between the two alternatives; the foregoing notwithstanding, as we continued to validate the assumption of normality – we applied the Shapiro-Wilks statistical test–, the *p*-value was lower than 0.05 (0.0139), which shows that the data do not meet the hypothesis of normality.

Therefore, we moved on to use a non-parametric test for the analysis of two independent samples, specifically, the Mann-Whitney-Wilcoxon test, and replaced our own pair of statistical hypothesis by using the median as a parameter:

H2o: MedianPD = MedianVLE;

H2a: MedianPD <> MedianVLE

This test is made by combining two samples, sorting the data from lower to higher and comparing average ranges of the two samples in the combined data. Table 7 shows the results of the statistical test.

Because the *P*-value is lower than 0.05, it may be concluded that there is a statistically significant difference between the medians of the alternatives with a level of confidence of 95.0%; therefore, it is possible to reject the hypothesis of nullity and to accept the alternative hypothesis.

MedianPD <> MedianVLE

Table 7. Results of the Mann-Whitney-Wilcoxon test for the time variable

Factor	Count	Average range	Statistical	P-Value
PP	7	16.0	14.0	0.00974341

LVE	14	8.5	-	-

Analysis of opinions

As part of the empirical study with learners, we prepared an *ex profeso* instrument based on the Likert scale (see figure 5), where the first two items value aspects of usability, items 3-9 are intended to evaluate incorporation of VLE's gamification elements, and item 10 collects the opinions of the implemented instructional dynamics as part of scheme 1 of the proposed instructional model.

Instrument for empirical evaluation of the instructional model implemented computationally

Ending time: ____________ Student: ______________________________

Instructions: based on the following statements, mark with an "X" the box that corresponds to the degree to which you are in agree or disagree with these		TA Total Agreement ACC in ACCordance NA Does not Apply DA in DisAgreement TD Totally Disagree				
		TA	ACC	NA	DA	TD
01	The effort required to learn to use the environment learning has been minimal	6	3	1	4	0
02	The time available for the instructional session was adequate	8	4	1	0	1
03	The descriptions used for the challenges and their respective answers were clear	2	7	3	2	0
04	The level of complexity of the challenges, in each of the four blocks, was appropriate	11	2	0	0	1
05	The dynamics of feedback (# of interventions maximum) for the challenges was appropriate	6	4	4	0	0
06	The descriptions used for feedback were clear	4	3	6	0	1
07	The availability of a progress bar during my session in the environment was useful to me	8	3	2	0	1
08	The availability of a leaderboard during my session in the environment was useful	4	4	5	0	1
09	The use of badges, as an award dynamic, was appropriate for me	4	3	5	1	1
10	The dynamics of evaluation through the environment is more entertaining that an evaluation (on paper)	10	1	2	0	1

Figure 5. Opinions of learners with the VLE dynamic

Opinions indicate that 64% of learners stated that the effort to learn and, in their case, to use the VLE was at a minimum and 86% gave a positive statement in respect of time available for the session activity.

In the case of opinions on the gamification elements incorporated to the model and, therefore, implemented in VLE, the behavior was as follows: regarding the construct of challenges, 67% gave their opinion in the sense that the descriptions were clear and 93% said that complexity thereof was proper. About feedback as a gamification element, 71% said that the dynamic used was positive; however, only 50% said that the descriptions were clear; it should be mentioned that 43% did not make any opinion on this item in any sense.

Regarding the progress bar gamification element, 79% said that it was useful, and on the position table element, only 57% said that it was useful. On the other hand, using badges as a reward dynamic reported 50% of positive opinions, and only 7% considered it negative. Finally, regarding the dynamic created by VLE, 76% of learners thought it was more amusing as compared with the traditional one.

CONCLUSIONS

In this article we have presented a configurable and computable instructional model based on gamification elements, empirically valued by means of a case in the software engineering educational area. The model incorporates three constructs: challenge, block and scheme, based on which the pedagogic intervention proposal was organized in learning scenarios on a specific domain.

The research-action methodology allows a continual process, where the researcher, in his role as a teacher, designs structured learning scenarios; in our case, assisted by virtual environments to incorporate innovative dynamics where it is possible to configure interaction with the environment in an individual and collaborative manner with a peer, as well as under a competitive scheme aimed to reinforce competences.

We believe that the proposal to offer a configurable instructional model for designing learning scenarios contrasts most of primary studies where *ad hoc* intervention experiences are reported (Mora *et al.*, 2017), which results in a contribution in the instructional design field.

On the other hand, unlike most of the primary studies found in literature (Diuecheva *et al*., 2015), the article reports a first empirical evaluation of the model. In this case study, we have used scheme 1 for a reinforcement dynamic on aspects of the software engineering area, specifically, proficiency in designing databases. For the experimental study, we have proposed a mode type applied to the dynamics as a factor controlled by the researcher, with two procedures: the traditional dynamics of employing a paper-based document for the performance test, and using a configured VLE based on the proposed model. Depending variables under consideration were the time devoted by the learner to the activity and the points earned at the end.

From the statistical analysis, we concluded that even when the median of points reached by learners who used VLE is greater and shows lower variability than the task made by learners who performed the activity by using the traditional method, this variable has no statistically significant differences, which is an indication that the achievement is similar.

In this sense, studies that report some kind of evaluation, generally, are focused on the motivational aspect as a learning ally (Da Rocha, Gomez & De Melo, 2016), without making a learning contrast *per se*. For this reason, we believe it is important to leave evidence that this instructional strategy, although not significantly improving achievement, is not a distracting element in the learning process; notwithstanding, aspects such as VLE, the gamification elements incorporated to the model, and the instructional dynamic itself, caused a positive approval in the study of opinions, which is consistent with some of the lessons learnt (Llorens-Largo *et al*., 2016).

Regarding the second variable under analysis (time), there were statistically significant differences as learners used less time with VLE, as compared to learners who used PD –with similar data variability–. This finding is not attributable to the gamification component, rather to the computable element considered in the model, that is, to the inclusion of ICTs –through VLE– as part of the generated learning scenario. It is worth mentioning that, in circumstances such as those experienced to the Covid-19 pandemic, using VLE represents, in many cases, not an alternative, but the only way to instrument educational processes.

Finally, it is important to mention that, as we write this article, we have completed a second study with learners in the course of fundamentals of software engineering, in this case, we used scheme 2 of the instructional model; for this second pedagogical intervention, we collected positive opinions both regarding the competitive dynamics and the elements based on gamification incorporated to VLE.

ACKNOWLEDGEMENTS

We would like to thank Ministry of Public Education (SEP, by its acronym in English) for their support through the P/PROFEXCE-2020-31MSU0098J-13 project, as well as for the financial support received from the National Council of Science and Technology through the CONACYT CVU-814668 scholarship.

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HOW TO CITE:

Aguilar Vera, Raúl Antonio; Briceño Arceo, Erika Eunice; Díaz Mendoza, Julio Cesar & Ucán Pech, Juan Pablo. (2020). Configurable and computable instructional model based on gamification elements: a case study on education in software engineering. *Apertura*, *12*(2). http://dx.doi.org/10.32870/Ap.v12n2.1905